

WHAT IS CLAIMED IS:

1. A concurrency control method in a transaction processing system for processing a plurality of transactions in parallel with respect to hierarchical data, the concurrency control method comprising:
  - producing a copy of the hierarchical data at a time of starting an access to the hierarchical data by each transaction;
  - judging whether a collision between one of reading access or writing access to be made by a first transaction with respect to a copy of the hierarchical data for the first transaction and another one of reading access or writing access made by the second transaction with respect to a copy of the hierarchical data for the second transaction will occur or not;
  - carrying out a processing for avoiding the collision when the judging step judges that the collision will occur; and
  - reflecting a writing access made by the first transaction with respect to a copy of the hierarchical data for the first transaction, on the hierarchical data, when the first transaction is to be finished normally, and reflecting the writing access also on a copy of the hierarchical data for the second transaction if the second transaction is not finished

yet.

2. The concurrency control method of claim 1, wherein the judging step judges whether the collision will occur or not, according to whether data looked up by making the reading access without taking the writing access into consideration and data looked up by making the reading access by taking the writing access into consideration are identical or not.

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3. The concurrency control method of claim 1, wherein when the first transaction is to make the reading access with respect to a copy of the hierarchical data, the judging step judges whether the collision will occur or not according to whether first data looked up by making the reading access with respect to a copy of the hierarchical data for the first transaction and second data looked up by making the reading access with respect to data obtained by merging a copy of the hierarchical data for the first transaction and a copy of the hierarchical data for the second transaction are identical or not.

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4. The concurrency control method of claim 3, wherein the judging step judges that the collision will not occur when the first data and the second data are

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judged as identical for all transactions that can be the second transaction, and judges that the collision will occur otherwise.

5 5. The concurrency control method of claim 1, further comprising:

making the writing access with respect to a shared copy produced by copying the hierarchical data in order to reflect writing accesses made by all transactions  
10 that make accesses to the hierarchical data, when the first transaction is to make the writing access with respect to a copy of the hierarchical data;

wherein when the first transaction is to make the reading access with respect to a copy of the  
15 hierarchical data, the judging step judges whether the collision will occur or not according to whether first data looked up by making the reading access and second data looked up by making the reading access with respect to the shared copy of the hierarchical data are  
20 identical or not.

6. The concurrency control method of claim 5, wherein the judging step judges that the collision will not occur when the first data and the second data are  
25 judged as identical, and judges that the collision will occur when the first data and the second data are

judged as not identical.

7. The concurrency control method of claim 5, wherein  
when there is an upper limit to a number of shared  
5 copies that can be recorded, those shared copies which  
have a higher possibility of being utilized at a time  
of reproducing a state in which the reading access is  
to be made later on are recorded at a higher priority,  
among the shared copies corresponding to states at  
10 times of the writing accesses with respect to the  
hierarchical data.

8. The concurrency control method of claim 1, wherein  
when the first transaction is to make the writing  
15 access with respect to a copy of the hierarchical data,  
the judging step judges whether the collision will  
occur or not according to whether first data looked up  
by making the reading access of the second transaction  
and second data looked up by making the reading access  
20 of the second transaction with respect to a state of  
the hierarchical data after the writing access are  
identical or not, for all reading accesses by all  
transactions that make accesses to the hierarchical  
data and that can be the second transaction.

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9. The concurrency control method of claim 8, wherein

the judging step judges that the collision will not occur when the first data and the second data are judged as identical for all reading accesses of all transactions that make accesses to the hierarchical data and that can be the second transaction, and judges that the collision will occur otherwise.

10. The concurrency control method of claim 8, further comprising:

10        recording an access sequence of accesses made with respect to a copy of the hierarchical data by each transaction, for each one of all transactions that make accesses to the hierarchical data;

         wherein the judging step obtains all reading  
15        accesses of all transactions that make accesses to the hierarchical data and that can be the second transaction, by looking up a record of the access sequence.

20        11. The concurrency control method of claim 8, further comprising:

         recording data looked up by making the reading accesses;

         wherein the judging step obtains the first data by  
25        looking up a record of the data looked up.

12. The concurrency control method of claim 8, wherein the judging step obtains the first data as data obtained by making the writing access that was made by the second transaction before the reading access, with  
5 respect to a state of the hierarchical data at a start of the second transaction, and then making the reading access with respect to a state of the hierarchical data after the writing access.

10 13. The concurrency control method of claim 8, further comprising:

making the writing access with respect to a shared copy produced by copying the hierarchical data in order to reflect writing accesses made by all transactions  
15 that make accesses to the hierarchical data, when the first transaction is to make the writing access with respect to a copy of the hierarchical data; and

storing states of the shared copy at timings at which the writing accesses were made by some of the  
20 transactions that make accesses to the hierarchical data;

wherein the judging step obtains the first data as data obtained by reproducing a state of the hierarchical data at a timing at which the reading  
25 access was made by selecting one of stored states of the shared copy which is close to the state of the

hierarchical data at a timing at which the reading  
access was made and making the writing access that was  
made by the second transaction with respect to a  
selected state of the shared copy according to need,  
5 and then making the reading access with respect to a  
reproduced state of the hierarchical data.

14. The concurrency control method of claim 13,  
wherein when there is an upper limit to a number of  
10 shared copies that can be recorded, those shared copies  
which have a higher possibility of being utilized at a  
time of reproducing a state in which the reading access  
is to be made later on are recorded at a higher  
priority, among the shared copies corresponding to  
15 states at times of the writing accesses with respect to  
the hierarchical data.

15. The concurrency control method of claim 8, wherein  
the judging step obtains the second data as data  
20 obtained by making the writing access of the second  
transaction with respect to a state after the writing  
access was made with respect to a copy of the  
hierarchical data for the first transaction, and then  
making the reading access with respect to a state of  
25 the hierarchical data after the writing access of the  
second transaction.

16. The concurrency control method of claim 8, further comprising:

making the writing access with respect to a shared  
5 copy produced by copying the hierarchical data in order  
to reflect writing accesses made by all transactions  
that make accesses to the hierarchical data, when the  
first transaction is to make the writing access with  
respect to a copy of the hierarchical data; and

10 storing states of the shared copy at timings at  
which the writing accesses were made by some of the  
transactions that make accesses to the hierarchical  
data;

wherein the judging step obtains the second data  
15 as data obtained by reproducing a state of the  
hierarchical data at a timing at which the reading  
access is to be made by selecting one of stored states  
of the shared copy which is close to the state of the  
hierarchical data at a timing at which the reading  
20 access is to be made, making the writing access that  
was made by the first transaction after that timing,  
with respect to a selected state of the shared copy,  
and making the writing access that was made by the  
second transaction according to need, and then making  
25 the reading access with respect to a reproduced state  
of the hierarchical data.



17. The concurrency control method of claim 16,  
wherein when there is an upper limit to a number of  
shared copies that can be recorded, those shared copies  
5 which have a higher possibility of being utilized at a  
time of reproducing a state in which the reading access  
is to be made later on are recorded at a higher  
priority, among the shared copies corresponding to  
states at times of the writing accesses with respect to  
10 the hierarchical data.

18. The concurrency control method of claim 1, wherein  
when the judging step judges that the collision will  
occur, the carrying out step carries out the processing  
15 for keeping those transactions that are determined  
according to prescribed criteria among transactions  
related to the collision, to wait until other  
transactions related to the collision are finished.

20 19. A transaction processing system for processing a  
plurality of transactions in parallel with respect to  
hierarchical data, comprising:

a copying unit configured to produce a copy of the  
hierarchical data at a time of starting an access to  
25 the hierarchical data by each transaction;

a judging unit configured to judge whether a

collision between one of reading access or writing  
access to be made by a first transaction with respect  
to a copy of the hierarchical data for the first  
transaction and another one of reading access or  
5 writing access made by the second transaction with  
respect to a copy of the hierarchical data for the  
second transaction will occur or not;

a processing unit configured to carry out a  
processing for avoiding the collision when the judging  
10 unit judges that the collision will occur; and

a reflecting unit configured to reflect a writing  
access made by the first transaction with respect to a  
copy of the hierarchical data for the first  
transaction, on the hierarchical data, when the first  
15 transaction is to be finished normally, and reflect the  
writing access also on a copy of the hierarchical data  
for the second transaction if the second transaction is  
not finished yet.

20 20. A computer program product for causing a computer  
to function as a transaction processing system for  
processing a plurality of transactions in parallel with  
respect to hierarchical data, the computer program  
product comprising:

25 a first computer program code for causing the  
computer to produce a copy of the hierarchical data at

a time of starting an access to the hierarchical data  
by each transaction;

a second computer program code for causing the  
computer to judge whether a collision between one of  
5 reading access or writing access to be made by a first  
transaction with respect to a copy of the hierarchical  
data for the first transaction and another one of  
reading access or writing access made by the second  
transaction with respect to a copy of the hierarchical  
10 data for the second transaction will occur or not;

a third computer program code for causing the  
computer to carry out a processing for avoiding the  
collision when the second computer program code judges  
that the collision will occur; and

15 a fourth computer program code for causing the  
computer to reflect a writing access made by the first  
transaction with respect to a copy of the hierarchical  
data for the first transaction, on the hierarchical  
data, when the first transaction is to be finished  
20 normally, and reflect the writing access also on a copy  
of the hierarchical data for the second transaction if  
the second transaction is not finished yet.